ANNEX A

Technical Description of the Connexion By Boeing^{SM} Maritime System

1 INTRODUCTION

The Boeing Company ("Boeing") proposes to operate a global network of Ku-band earth stations onboard vessels ("ESVs"), called Connexion by Boeing^{SM} Maritime ("CBBM"), which will provide broadband communications services to vessel passengers, crew, owners and operators, as well as to other customers in a variety of maritime applications. Through this satellite-based system, CBBM customers will be able to access a full range of broadband services while at sea, in port and along navigable rivers and inland waterways.

2 SERVICE OVERVIEW

Boeing plans to offer its global CBBM service to a wide range of maritime customers, including commercial ship owners and operators, government users, oil and gas platforms, maritime and river barges, and others. CBBM's broadband services will address the business operations, crew and passenger connectivity, entertainment and other communications needs of the maritime community. The maritime communications capabilities of the CBBM system will be available virtually anywhere in the world, including open ocean regions, along major commercial sea lanes, in ports and along navigable rivers and waterways.

The broadband capabilities of the CBBM system will allow customers to access a wide range of important services, including:

1. ***High-Speed Internet Access –*** The CBBM system will provide the capability to surf the World Wide Web at broadband speeds just as if the user was connected to a home or office high-speed connection. Thus, users will be able to send and receive e-mail, follow breaking news developments, and do virtually anything else that can be done over the Internet – all in real time and at broadband speeds.
2. ***Corporate Intranet Access –*** Maritime corporate travelers and vessel crew members will have the potential to log on to their company's intranet while on-board CBBM-equipped vessels, thus allowing travelers to stay in contact with colleagues and access to corporate networked files. The CBBM system will also support secure Virtual Private Network ("VPN") tunneling software for enhanced security.

3. ***Navigation and Destination Planning Information* –** Vessel owners and operators will have expanded access to information for navigation and route planning, including electronic navigation charts, real-time weather information and other applications. Additional applications such as interactive port and harbor maps, destination guides, regulatory and security updates and other destination information will afford vessel passengers and crew more enjoyable and efficient port calls and travel experiences.
4. ***Voice, Fax and Entertainment* –** The CBBM system's high-speed connectivity allows users to access voice and fax products to stay connected anywhere in the CBBM coverage area, and to view ship-board entertainment in real-time even in remote regions of the world's oceans.
5. ***Ship Operational Information* –** Vessel owners and operators will be able to share operations information and instructions with vessel masters and crews, remotely access information such as location, heading and speed, supply and cargo status, and other operational data; and share important commercial trade information with vessels virtually anywhere they may be located.
6. ***Other Maritime Applications*** – The broadband capabilities and services noted above are not only available to ocean-going commercial vessels, but also to government and private vessel operators and other maritime customers. For example, the CBBM system covers major maritime oil and gas regions and is capable of providing service to drilling platforms and related facilities. In addition, given the CBBM system's seamless coverage of all major land masses, it can provide service to smaller vessels, barges and other maritime facilities along the navigable rivers and inland waterways in virtually every country around the world.

In sum, the CBBM system offers broadband communications capabilities that can be used for a wide range of applications, including high-speed Internet access and data communications, voice and fax services, entertainment and non-safety related maritime communications services. The high-speed connectivity provided through the CBBM system also makes possible other new and innovative applications designed to improve the efficiency and performance of vessel operations and maritime communications.

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3 CBBM NETWORK OVERVIEW

The CBBM system will operate using the same network control facilities and satellites as the Connexion by Boeing[SM] Aeronautical Mobile-Satellite Service ("AMSS") system, and will benefit from the considerable investment made in, and experience Boeing has gained from, operating this network. The CBBM network, as shown in Figure 1 below, is divided into three segments:

(1) A vessel segment composed of ESVs with a mechanically steered reflector antenna, and other on-board hardware and software components;

(2) a space segment consisting of leased Ku-band satellite transponders on various geostationary satellites to provide both open ocean and landmass coverage;

(3) a terrestrial segment consisting of Land Earth Stations ("LESs"), Network Operations Center ("NOC") and the Enterprise Operations Center ("EOC") to provide network control and support operations.

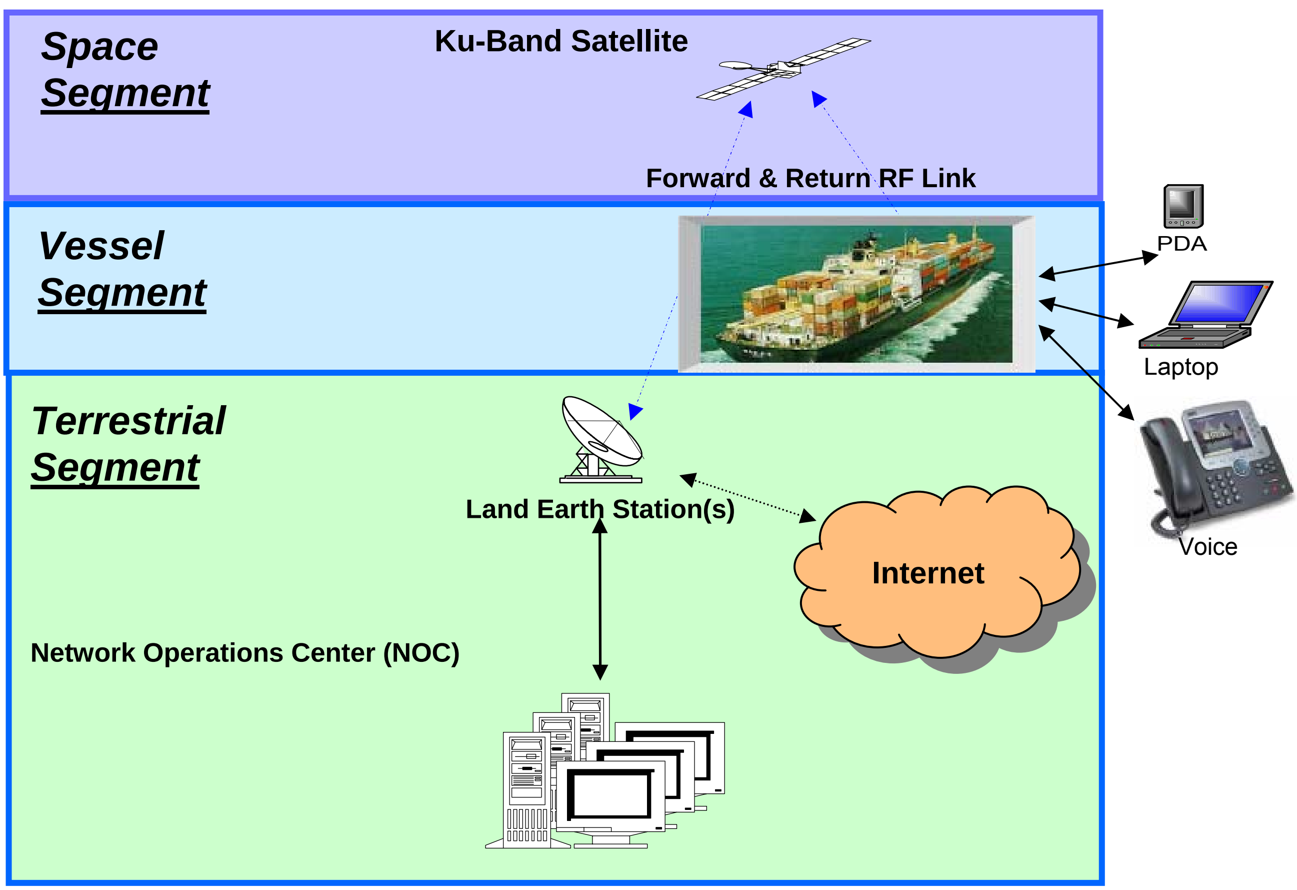

Figure 1 CBBM System Architecture

3.1 The Vessel Segment

The vessel segment is composed of the following subsystems:

- An Above Deck Unit ("ADU"), which includes the radome, antenna, antenna drive unit and support electronics (up and down converters, and power amplifier).
- A Below Deck Unit ("BDU"), which includes the modem, server and antenna controller.

The BDU is connected to a Vessel Distribution System, which is provided by the customer to route services to various end-user access points within the vessel. An end-user (*e.g.*, passenger or crew member) will be able to use a personal laptop computer, a Personal Digital Assistant ("PDA") or Voice-over-IP devices to connect to the VDS and access services delivered by the CBBM system.

3.2 The Space Segment

The space segment will utilize transponders of Ku-band geostationary satellites that have been previously coordinated and are otherwise authorized to provide service to CBBM-equipped vessels. Forward link data will be uplinked from an LES to the geostationary satellite using standard Fixed-Satellite Service ("FSS") bands and then downlinked from the satellite to the ESV in portions of the 11.2 -12.75 GHz band (the full global Ku-band downlink allocation), depending on the region in which the ESV is located and the capabilities of the serving satellite. Similarly, return link data will be up-linked from the ESV to the satellite using the 14.0 – 14.5 GHz band (the full global Ku-band uplink allocation) and then down-linked from the satellite back to the LES using standard FSS bands. The forward and return links will use full transponders, or fractional transponders (*i.e.*, signals that have a bandwidth smaller than the full transponder's bandwidth) depending on the traffic demand in the region.

To provide coverage of international shipping routes, Boeing will lease capacity on a number of geostationary satellites. Satellite coverage areas will be selected to provide a small amount of overlap at the region boundary so that the system coverage is contiguous.

3.3 The Terrestrial Segment

The terrestrial segment consists of several Land Earth Stations ("LESs"), a Network Operations Center ("NOC") and an Enterprise Operations Center ("EOC").

3.3.1 Land Earth Station

Each LES will utilize leased capacity on existing commercial gateway earth stations in one of five regional locations. The current network has five (5) LESs: Leuk, Switzerland; Littleton, Colorado, USA; Moscow, Russia; Ibaraki, Japan; and Lake Cowichan, Canada. These earth station facilities are licensed separately to their operators by the respective licensing administrations. Each of the LESs provides the forward and return links, via their serving satellites, between CBBM ESVs and the Internet, as well as the NOC and EOC. The LESs are connected directly to the Internet at each location, and to the NOC using leased capacity on a private terrestrial network.

3.3.2 Network Operations Center

The NOC serves as the central monitoring and control facility for the CBBM network. The NOC is connected to each of the LESs in the system using leased capacity on private terrestrial networks and serves all of the satellite coverage regions in the CBBM network. The NOC grants authorization for ESVs to begin transmitting, monitors ESV transmission performance and coordinates the hand-off of an ESV transitioning between two satellite coverage regions. In addition, the NOC is connected to the Internet and the various customer care and billing centers needed to support CBBM using leased capacity on private terrestrial networks. The links between the NOC and the other system components are shown in Figure 2.

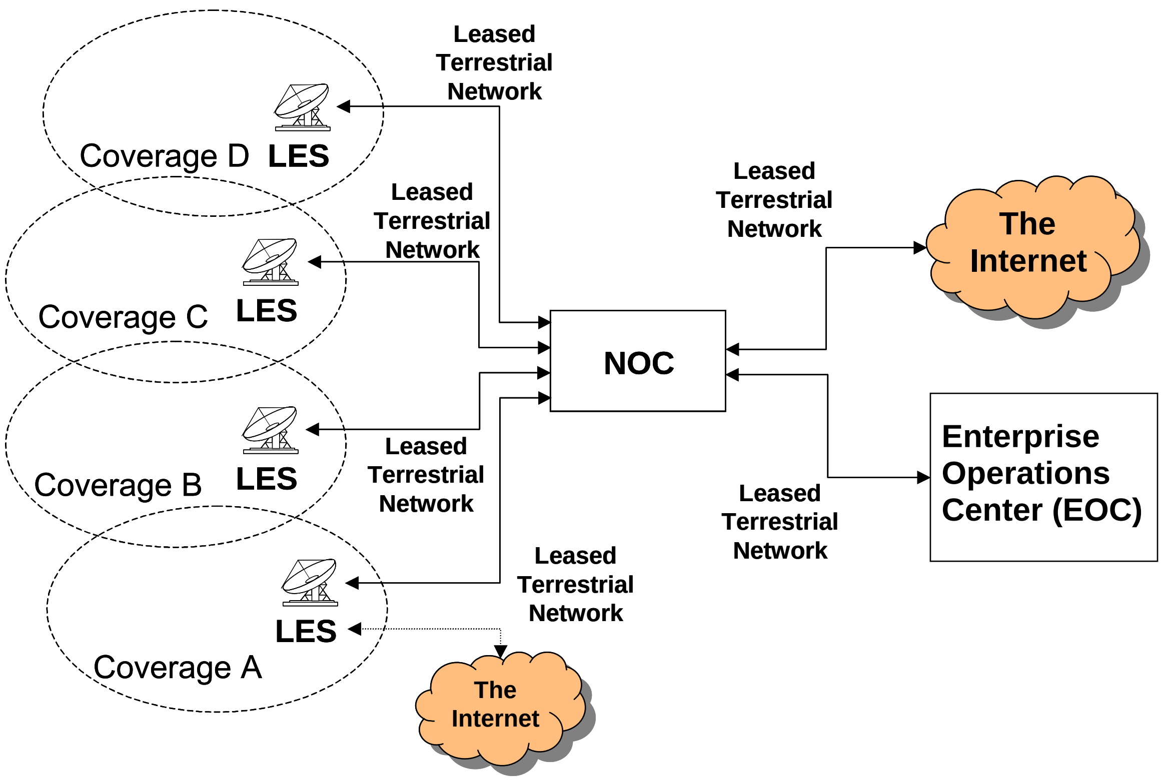

Figure 2 Terrestrial segment - Links between the NOC and the Other Network Components

Boeing will retain control of operation of the CBBM network. Boeing will have the ability to shut down the network (or relevant parts of it) immediately if required.

4 ESV TECHNICAL SPECIFICATION

This section provides more detailed information on the ESV antenna that will be used for the CBBM system, the radiofrequency (“RF”) link waveform and power spectral density.

4.1 CBBM ESV Antenna

The CBBM system will use a mechanically steered reflector antenna, as shown in Figure 3. The antenna is installed near the top of a vessel, inside a radome, and is designed to track the desired satellite over a large geographic range and through the most extreme movement expected of a vessel.

Figure 3 CBBM Reflector antenna (radome not shown)

4.2 ESV Antenna Subsystem Characteristics

The CBBM ESV antenna characteristics are summarized in Table 1. The measured E- and H-plane e.i.r.p. patterns for this antenna, are shown in Section 4.2.2.

Antenna parameters	Specifications
Aperture Dimensions	100 cm circular
Antenna Beam-width (3 dB)	1.4º
Transmit Band	14.0 GHz to 14.5 GHz
Receive Band	11.2 GHz to 12.75 GHz
Transmit Gain	41.5 dBi
Receive Gain	39.9 dBi
Maximum EIRP	48.2 dBW
Maximum G/T	17.3 dB/K
Antenna Polarization	Tx: Single Variable Linear Rx: Dual Orthogonal Linear

Table 1 CBBM ESV - Reflector Antenna Characteristics

4.2.1 ESV Antenna Pointing Control

Accurate pointing of transmit and receive beams is achieved by using angular rate sensors, and closed loop conical scan tracking of the RF signal from the satellite by the receive beam. The common receive and transmit reflector aperture provides accurate pointing of the transmit beam.

Simulations of the pointing and tracking design and testing of the antenna show a transmit pointing error less than or equal to 0.2 degrees, 1 sigma (including 0.1 degree conical scan offset) when vessel motion is taken into account.

In the CBBM system, several ESVs may transmit simultaneously and the overall off-axis e.i.r.p. envelope is controlled by the NOC. The calculation of the aggregate off-axis e.i.r.p. envelope takes into account the pointing error of the individual ESV antennas, and the aggregate envelope is the direct equivalent of the emissions envelope produced by a single TDMA ESV transmitter.

In addition, the antenna control software will determine the pointing error of the antenna. A measurement of antenna pointing error is made every 100 ms. If this error exceeds 0.5 degrees, the antenna control software will terminate RF transmissions within 95 msec. Transmission will not resume until the pointing error is less than 0.2 degrees.

Control of receive and transmit polarization is performed by computing polarization commands based on ship's position and attitude, satellite location and selected polarization.

4.3 On-Axis e.i.r.p. Monitoring

The on-axis e.i.r.p. of the ESV terminal is ascertained from direct measurement of the RF power delivered to the antenna. The Power Amplifier ("PA") contains a calibrated coupler and a calibrated power detector to measure the power delivered to the output port of the PA. The e.i.r.p. of the ESV is then calculated, based on knowledge of the antenna gain and losses downstream of the PA (including the radome loss).

4.4 Aggregate Off-Axis e.i.r.p

The CBBM system uses a Code Division Multiple Access ("CDMA") transmission scheme, which will permit multiple co-frequency transmissions from different ESVs to be simultaneously received at the same satellite. In order to maintain compatibility with adjacent FSS satellites, the aggregate off-axis e.i.r.p. produced by the all CBBM terminals operating on a single frequency will be controlled so as to meet the off-axis e.i.r.p. limits described in Section 5.1.

Figures 4 and 5 show the e.i.r.p. spectral density of a single CBBM ESV with respect to the e.i.r.p. spectral limits of 25.222(a)(1). The E-plane could correspond to either the azimuth or elevation plane, depending on the signal polarization. Figure 6 shows the cross polarization e.i.r.p. spectral density of a single CBBM ESV.

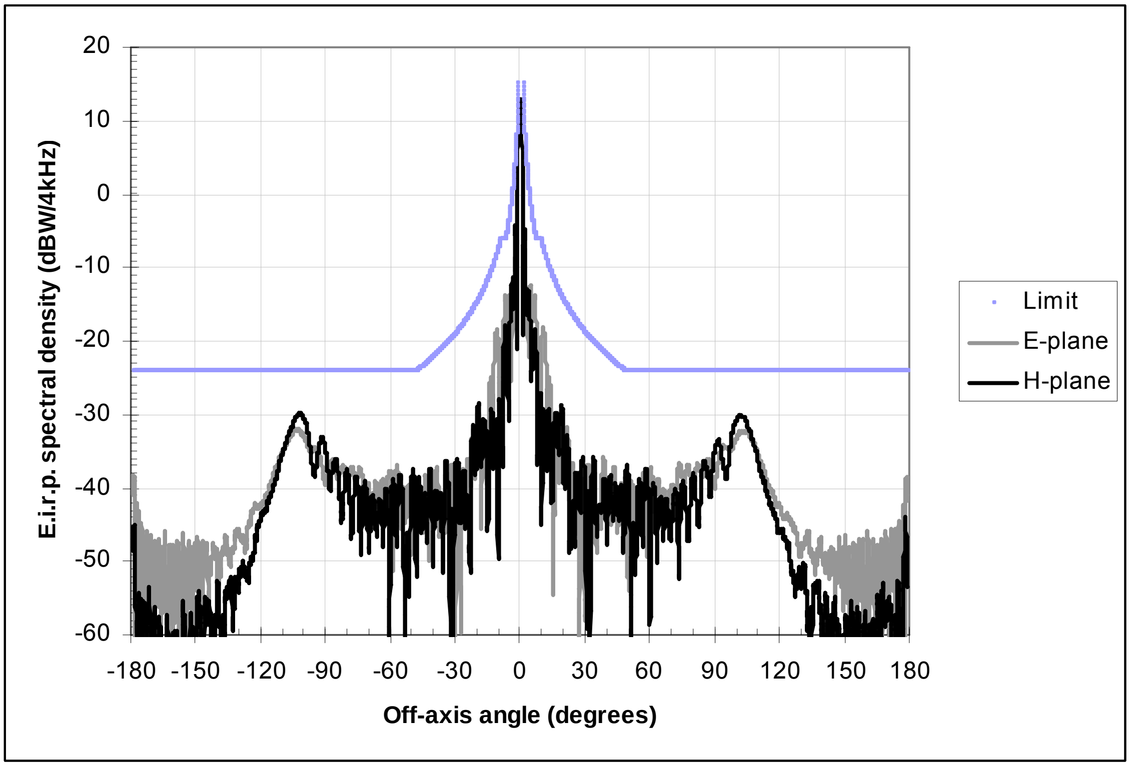

Figure 4. CBBM co-polarized e.i.r.p. spectral density - -180 to 180 degrees

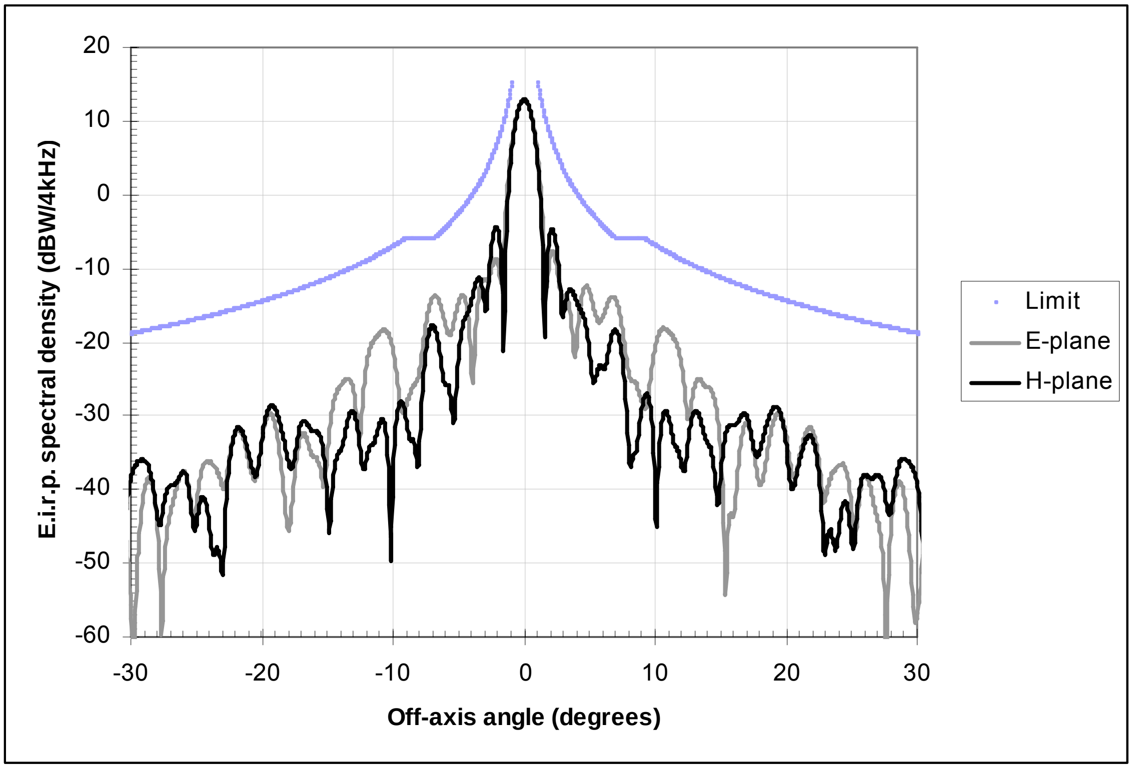

Figure 5. CBBM co-polarized e.i.r.p. spectral density - -30 to 30 degrees (also includes -10 to 10 degree data)

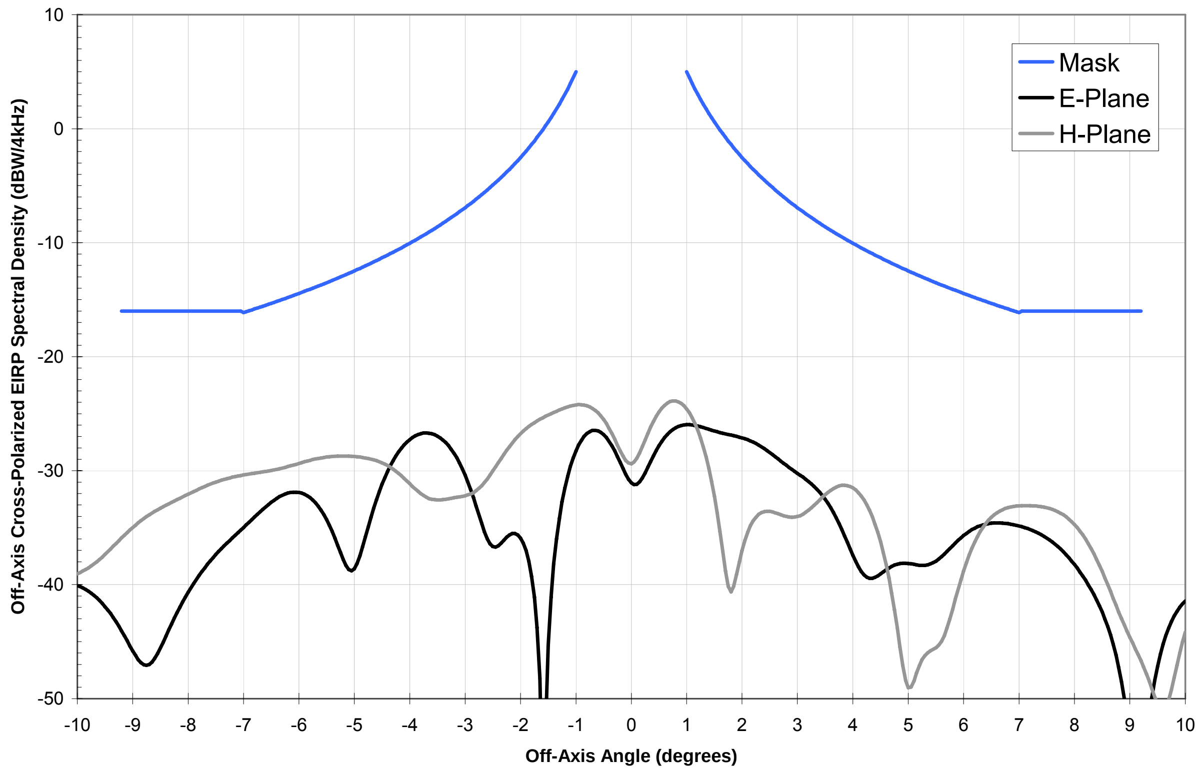

Figure 6. CBBM cross-polarized e.i.r.p. spectral density - -10 to 10 degrees

4.5 Waveform Definition

The CBBM system will use identical waveforms to the Connexion by Boeing^{SM} AMSS system. Both the forward and return link waveforms use Direct Sequence Spread Spectrum ("DSSS") modulation to reduce the waveform e.i.r.p spectral density. Signals will be spread up to 90% of the fraction of the transponder that is used.

The waveform characteristics of the CBBM ESV for both the forward and return links are shown in Table 2. The spectral characteristics for the forward and return links are nearly identical. An added benefit of spread spectrum modulation is the reduction of interference from other sources into CBBM signals. The carrier bandwidth of each ESV is typically 13.5 MHz, but depending on the satellite link conditions it can be set to different values between 6.75 MHz to 32.4 MHz.

For each CBBM ESV, the forward link operates at an information rate of typically 5 Mbps (with a maximum of 30 Mbps), while the CBBM ESV return link operates at information rates between 16 and typically 256 kbps (with a maximum of 2048 kbps). The spectral characteristics for the forward and return links are nearly identical.

Typical 3 dB Bandwidth	6.75 MHz to 32.4 MHz
Typical ITU Emission Designation	6M75G7W and 32M4G7W[1]
Modulation	DSSS / Offset-QPSK
Multiplex Carrier Access Scheme	Forward Link : Single channel per carrier with packet multiplexing Return Link: Code Division Multiple Access (CDMA)
Filtering	Square Root Raised Cosine (SRRC), $\alpha = 0.35$

Table 2 Waveform Characteristics

4.6 Link Power Spectral Density

On the return link, the maximum uplink e.i.r.p. spectral density from an individual ESV will be between 7.6 dBW/4kHz and 14.4 dBW/4 kHz for return link signal bandwidths between 32.4 MHz and 6.75 MHz. The aggregate uplink e.i.r.p. density for all ESVs sharing a transponder will not exceed approximately 19 dBW/4kHz when operating under the U.S. off-axis e.i.r.p. limits and no more than 31 dBW/4kHz when operating under the off-axis e.i.r.p. limits set forth in Resolution 902.

The downlink e.i.r.p. spectral density from the satellite on the forward link is dependant on the exact satellite e.i.r.p. and spreading bandwidth used for that satellite. For a typical transponder, the down link e.i.r.p. spectral density will not exceed 12 dBW/4 kHz for a typical 32.4 MHz spread signal with an e.i.r.p. of 51 dBW.

4.7 Downlink PFD Limits

Boeing will keep its downlink power flux density (“PFD”) levels of carriers at the Earth’s surface in the 10.7-11.7 and 12.2-12.75 GHz bands at or below the applicable levels specified in Section 25.208(b) of the Commission’s Rules and Article 21.16 and Table 21-4 of the International Radio Regulations for various elevation angle ranges. Boeing will comply with the Commission and ITU PFD limits through the selection of forward link spreading bandwidths and, when necessary, transponder output back-off. The downlink PFD limit is not an issue for the return down link (satellite to land earth station) because of the very low downlink power density of this link, typically 10 to 20 dB below saturation.

The minimum spreading bandwidths required to comply with the ITU and FCC PFD limits for the each transponder service areas are shown below. For signal bandwidths narrower than those shown below, it would be necessary to introduce an output back-off

[1] Fractions of a transponder may be used for forward, or return-link, signals in order to more efficiently utilize space segment resources.

equal to the ratio between the signal bandwidth and the bandwidth given. By operating with spreading bandwidths greater than those in Table 3, or backing off the power as required, Boeing will be able to comply with the Commission and ITU downlink PFD limits.

Satellite	**Applicable Limit**	**Minimum Bandwidth at Saturation**
Intelsat 907	10.7-11.7 GHz	28.9 MHz
Estrela do Sul North Atlantic	10.7-11.7 GHz	11.8 MHz
SESAT	10.7-11.7 GHz	9.4 MHz
Yamal-200	10.7-11.7 GHz	16.7 MHz
AsiaSat 3S North East Asia	12.20-12.75 GHz	2.4 MHz
AsiaSat 3S South West Asia	12.20-12.75 GHz	7.1 MHz
Superbird-C South East Asia	12.20-12.75 GHz	10.1 MHz
Superbird-C Indian Ocean Spot	12.20-12.75 GHz	18.7 MHz

Table 3. Minimum Bandwidth to meet PFD limits

4.8 Link budgets

Table 3 details the Link Budget Analysis for the CBBM system.

Satellite name/Beam	EDS NAOR	I907 NAOR	SESAT	Yamal 200	AsiaSat 3S EastAsia	AsiaSat 3S-SA	SB-C_SE	IA6	AMC-4	AMC6	EDS NAFTA
Sat lon (deg)	-63.1	-27.5	36.0	90.0	105.5	105.5	144.0	-93.0	-101.0	-72.0	-63.0
# Satellite->ESV:											
Freq (GHz)	11.6	11.6	11.6	11.5	12.5	12.3	12.4	12.0	11.7	12.0	12.0
Satellite EIRP (dBW)	48.0	52.0	49.0	47.5	48.0	52.0	48.6	48.1	48.0	44.0	46.0
Path loss (dB)	205.4	205.5	205.5	205.2	206.0	205.7	205.7	205.4	205.2	205.3	205.4
Rain availability	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total channel losses (dB)	207.4	207.3	205.8	205.5	208.4	207.9	207.9	206.3	206.2	205.7	205.9
Gain ant (dBi)	39.5	39.4	39.4	39.4	39.8	39.7	39.8	39.6	39.5	39.6	39.6
Pwr rcvd signal (dBW)	-120.1	-116.0	-117.5	-118.7	-120.8	-116.4	-119.7	-118.8	-118.9	-122.2	-120.4
Temp_noise rcvr sys (K)	309.3	296.5	218.9	217.6	324.9	319.6	317.1	262.2	261.6	228.9	231.7
Spread bandwidth (MHz)	32.4	32.4	32.4	64.8	30.2	30.2	32.4	24.3	31.0	32.4	15.5
Noise pwr (dBW/Hz)	-203.7	-203.9	-205.2	-205.2	-203.5	-203.6	-203.6	-204.4	-204.4	-205.0	-204.9
I_total reduced (dBW)	-135.2	-128.1	-130.0	-133.3	-133.5	-129.1	-132.5	-129.9	-129.3	-133.5	-132.7
Io (dBW/Hz)	-210.8	-203.7	-205.6	-211.9	-209.1	-204.7	-208.1	-204.2	-204.9	-209.1	-208.2
No+Io (dBW/Hz)	-202.9	-200.8	-202.4	-204.4	-202.4	-201.1	-202.3	-201.3	-201.6	-203.6	-203.3
C/(No+Io) (dB/Hz)	82.8	84.8	84.9	85.6	81.6	84.7	82.5	82.5	82.8	81.3	82.8
Specified datarate (Mb/s)	7.0	7.0	7.5	10.0	6.5	6.5	5.0	10.0	5.0	5.0	10.0
Eb/No (dB)	13.9	15.5	15.4	15.0	13.1	15.7	14.9	12.2	15.1	13.8	12.5
Eb/No rqmt at spec rate (dB)	2.9	2.9	2.9	2.9	2.7	2.7	2.7	2.9	2.7	2.7	2.9
Eb/No extra margin (dB)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
spread bandwidth (Mhz)	21.7	21.7	23.3	31.0	30.2	30.2	31.0	15.5	23.3	31.0	15.5
Margin at specified datarate	9.9	11.5	11.4	11.0	9.3	11.9	11.1	8.2	11.3	10.0	8.5
# ESV->Satellite:											
Freq (GHz)	14.2	14.0	14.1	14.1	14.1	14.2	14.1	14.3	14.3	14.1	14.1
Spread bandwidth (MHz)	32.4	13.5	13.5	13.5	13.5	13.5	13.5	24.3	32.4	32.4	32.4
G/T sat (dB/K)	6.0	8.4	6.0	1.5	2.0	5.0	3.4	0.1	3.0	-5.0	1.0
- w/ backoff (dB)	0.0	-1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EIRP ant (dBi)	46.8	46.7	46.7	46.7	46.7	46.8	46.7	46.8	46.8	46.7	46.7
Path loss (dB)	207.1	207.2	207.2	207.0	207.1	206.9	206.8	206.9	207.0	206.7	206.8
Total channel losses (dB)	209.6	209.7	207.7	207.4	209.8	209.7	209.3	208.2	208.3	207.3	207.5
Gain sat rcv ant (dBi)	35.0	37.4	35.0	30.5	31.0	34.0	32.4	29.1	32.0	24.0	30.0
Pwr at sat rcvr in (dBW)	-127.8	-125.5	-125.9	-130.1	-132.0	-128.9	-130.1	-132.3	-129.5	-136.5	-130.8
Interference PSD (dB/Hz)	-205.0	-200.0	-195.0	-209.0	-200.0	-203.0	-200.0	-202.0	-200.0	-200.0	-205.0
No (dBW/Hz)	-199.6	-199.6	-199.6	-199.6	-199.6	-199.6	-199.6	-199.6	-199.6	-199.6	-199.6
No+Io uplink (dBW/Hz)	-198.5	-196.8	-193.7	-199.1	-196.8	-198.0	-196.8	-197.6	-196.8	-196.8	-198.5
C/(No+Io) uplink (dBHz)	70.7	71.2	67.8	69.0	64.7	69.0	66.6	65.3	67.3	60.2	67.7
Gnd C/(No+Io) (dBHz)	91.9	84.9	84.0	86.7	74.2	77.3	96.7	90.3	93.2	69.5	88.9
E2E C/(No+Io) (dBHz)	70.6	71.1	67.7	68.9	64.3	68.4	66.6	65.3	67.2	59.8	67.7
E2E datarate (Kb/s)	256.0	256.0	256.0	256.0	256.0	256.0	256.0	256.0	256.0	256.0	256.0
E2E Eb/No required (dB)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
E2E margin at @ rate (dB)	13.0	13.5	10.1	11.3	6.7	10.9	9.0	7.7	9.7	2.2	10.1

Table 3. CBBM System - Typical Link Budgets

Satellite name/Beam	AMC6	EDS_ NAFT A	AMC- 23_NP	AMC- 23_S WP	AMC- 23_SP	AMC- 23_SE P	I705	I706aS 3	Superb ird-C
Sat lon (deg)	-72.0	-63.0	172.0	172.0	172.0	172.0	-50.0	50.3	144.0
# Satellite->ESV:									
Freq (GHz)	12.0	12.0	11.7	11.7	11.7	11.7	11.5	12.0	12.5
Satellite EIRP (dBW)	44.0	46.0	45.0	44.0	50.0	45.0	48.0	46.2	52.0
Path loss (dB)	205.3	205.4	205.7	205.0	205.7	205.3	204.9	205.2	206.2
Rain availability	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total channel losses (dB)	205.7	205.9	206.5	207.3	206.0	206.2	205.1	205.5	206.7
Gain ant (dBi)	39.6	39.6	39.5	39.5	39.5	39.5	39.4	39.6	39.8
Pwr rcvd signal (dBW)	-122.2	-120.4	-122.2	-124.0	-116.7	-121.9	-117.8	-119.9	-115.0
Temp_noise rcvr sys (K)	228.9	231.7	246.5	325.1	218.9	261.5	218.5	229.8	225.0
Spread bandwidth (MHz)	32.4	15.5	24.3	24.3	24.3	24.3	32.4	32.4	32.4
Noise pwr (dBW/Hz)	-205.0	-204.9	-204.7	-203.5	-205.2	-204.4	-205.2	-205.0	-205.1
I_total reduced (dBW)	-133.5	-132.7	-136.2	-137.9	-131.4	-136.0	-131.5	-132.7	-129.7
Io (dBW/Hz)	-209.1	-208.2	-210.6	-212.3	-205.7	-210.3	-207.1	-208.2	-205.3
No+Io (dBW/Hz)	-203.6	-203.3	-203.7	-202.9	-202.4	-203.4	-203.0	-203.3	-202.2
C/(No+Io) (dB/Hz)	81.3	82.8	81.5	78.9	85.7	81.5	85.2	83.4	87.1
Specified datarate (Mb/s)	5.0	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Eb/No (dB)	13.8	12.5	14.0	11.6	17.4	14.0	17.0	15.6	18.4
Eb/No rqmt at spec rate (dB)	2.7	2.9	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Eb/No extra margin (dB)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
spread bandwidth (Mhz)	31.0	15.5	23.3	23.3	23.3	23.3	31.0	31.0	31.0
Margin at specified datarate	10.0	8.5	10.2	7.8	13.6	10.2	13.2	11.8	14.6
# ESV->Satellite:									
Freq (GHz)	14.1	14.1	14.2	14.2	14.2	14.2	14.3	14.1	14.2
Spread bandwidth (MHz)	32.4	32.4	32.4	32.4	32.4	32.4	32.4	32.4	13.5
G/T sat (dB/K)	-5.0	1.0	0.0	-1.0	6.0	-1.0	6.4	4.7	6.4
- w/ backoff (dB)	0.0	0.0	0.0	0.0	0.0	0.0	-1.4	-0.7	-1.4
EIRP ant (dBi)	46.7	46.7	46.7	46.7	46.7	46.7	46.8	46.7	46.8
Path loss (dB)	206.7	206.8	207.4	206.7	207.3	206.9	206.8	206.6	207.3
Total channel losses (dB)	207.3	207.5	208.5	209.7	207.9	208.3	207.1	207.2	207.9
Gain sat rcv ant (dBi)	24.0	30.0	29.0	28.0	35.0	28.0	35.4	33.7	35.4
Pwr at sat rcvr in (dBW)	-136.5	-130.8	-132.7	-134.9	-126.1	-133.5	-124.9	-126.7	-125.8
Interference PSD (dB/Hz)	-200.0	-205.0	-202.0	-202.0	-202.0	-202.0	-205.0	-205.0	-202.0
No (dBW/Hz)	-199.6	-199.6	-199.6	-199.6	-199.6	-199.6	-199.6	-199.6	-199.6
No+Io uplink (dBW/Hz)	-196.8	-198.5	-197.6	-197.6	-197.6	-197.6	-198.5	-198.5	-197.6
C/(No+Io) uplink (dBHz)	60.2	67.7	64.9	62.7	71.5	64.1	73.6	71.8	71.8
Gnd C/(No+Io) (dBHz)	69.5	88.9	77.7	75.5	84.3	76.9	82.1	81.4	85.1
E2E C/(No+Io) (dBHz)	59.8	67.7	64.7	62.5	71.3	63.9	73.0	71.3	71.6
E2E datarate (Kb/s)	256.0	256.0	256.0	256.0	256.0	256.0	256.0	256.0	256.0
E2E Eb/No required (dB)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
E2E margin at @ rate (dB)	2.2	10.1	7.1	4.9	13.7	6.3	15.4	13.8	14.1

Table 3. CBBM System - Typical Link Budgets (continued)

5 PROTECTION OF OTHER AUTHORIZED SERVICES

5.1 Fixed-Satellite Service ("FSS")

The CBBM system will protect FSS satellite receivers in the 14.0-14.5 GHz band by controlling the aggregate off-axis e.i.r.p spectral density in the direction of the geostationary arc emitted by ESV antennas to the level required by Ku-band VSAT operations, as discussed above in Section 4.2.2. When using satellites that have been coordinated for 2-degree spacing and/or to which the Commission's 2-degree spacing rules apply, the CBBM system will meet the off-axis e.i.r.p. limits given by §25.222 (a) (1)-(4):

(1) The maximum co-polarized component along the GSO arc of θ degrees from the antenna main beam will not exceed the limits, as given below:

15 – 25log(θ) dBW/4kHz	for $1.25° \le \theta \le 7.0°$
-6 dBW/4kHz	for $7.0° < \theta \le 9.2°$
18 – 25log(θ) dBW/4kHz	for $9.2° < \theta \le 48°$
-24 dBW/4kHz	for $48° < \theta \le 180°$

(2) In all other directions, the off-axis EIRP spectral density for co-polarized signals emitted from the ESV shall not exceed the following values:

18 – 25log(θ) dBW/4kHz	for $1.25° \le \theta \le 48°$
-24 dBW/4kHz	for $48° < \theta \le 180°$

(3) For θ >7°, the values given in paragraphs (a)(1) of this Section may be exceeded by no more than 10% of the sidelobes, provided no individual sidelobe exceeds the criteria given by more than 3 dB.

(4) In all directions, the off-axis EIRP spectral density for cross-polarized signals emitted from the ESV shall not exceed the following values:

5 - 25log(θ) dBW/4kHz	for $1.8° \le \theta \le 7°$
-16 dBW/4kHz	for $7° < \theta \le 9.2°$

Where θ is the angle in degrees from the axis of the main lobe.

5.2 Fixed Service ("FS")

The CBBM system will comply with the requirements of Resolution 902 in order to protect co-frequency FS systems. Before operating ESVs within 125 km of the potentially concerned administrations identified in Resolution 902, Annex 1, Boeing will obtain prior agreement for these operations from the concerned administration. However, Boeing expects that in most cases it will be possible to avoid using FS frequencies near concerned administrations.

Previous studies in ITU-R WP 4-9S have shown that the significant factor in determining the minimum distance is the maximum e.i.r.p. towards the horizon, which would be received by the FS system. In Resolution 902 (WRC-03), this is expressed as both a maximum e.i.r.p. level and a maximum e.i.r.p. density towards the horizon. These values of e.i.r.p. towards the horizon are based on the ESVs maximum transmit power at the flange and the gain of the antenna in the direction of the horizon.[2] CBBM emissions will meet both of these criteria and so the 1.0 m CBBM ESV antenna will

[2] Preliminary Draft Revision of Recommendation ITU-R Sf.1649, Guidance for Determination of Interference from Earth Stations on Vessels (ESVs) to Stations in the Fixed Service When the ESV Is Within the Minimum Distance, ITU-R Document 4-9S/71-E, Annex 4 of Annex 3, 18 May 2005.

have an interference effect on the terrestrial services which is no greater than that which would be caused with an antenna size of 1.2 m.

5.3 Radio Astronomy Service (“RAS”)

Boeing will coordinate with radio astronomy observatories within line of sight of navigable waters through the National Telecommunications and Information Administration (“NTIA”) Interdepartment Radio Advisory Committee (“IRAC”) to address potential interference to the RAS observations as required by §25.222(e).

Boeing has successfully coordinated with the National Science Foundation previously concerning operation of the Connexion by Boeing[SM] AMSS system and expects coordination of ESV operations to be completed in due course. Boeing will not operate ESVs within the areas specified above until such coordination has been concluded.

5.4 Space Research Service (“SRS”)

Boeing will coordinate with the operators of space research facilities in line-of-sight of navigable waters to address interference to these receivers as required by §25.222(d).

Boeing has successfully coordinated with NASA previously concerning operation of the Connexion by Boeing[SM] AMSS system and expects coordination of ESV operations to be completed in due course.